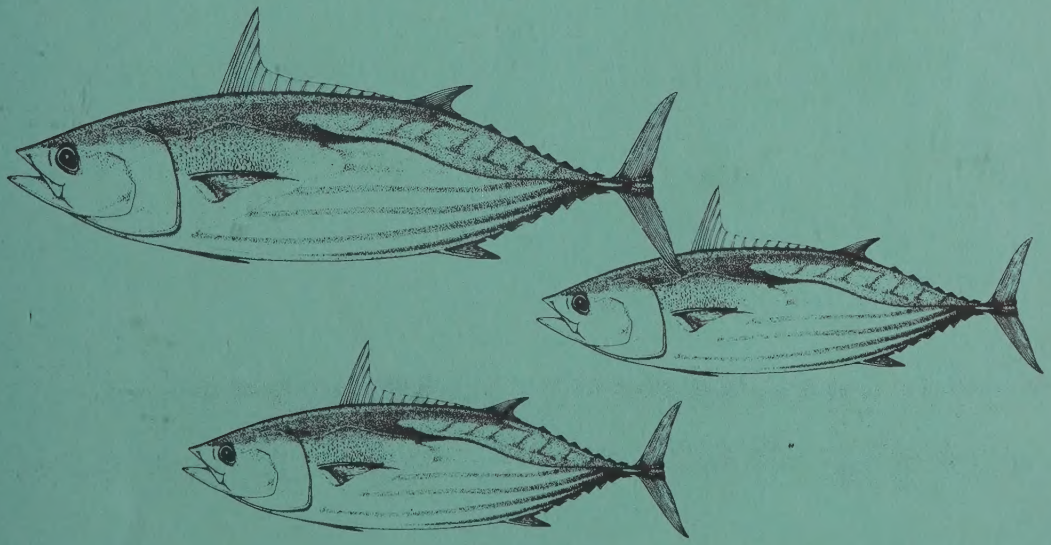
MAY 1978
No. 5

FISHING INFORMATION

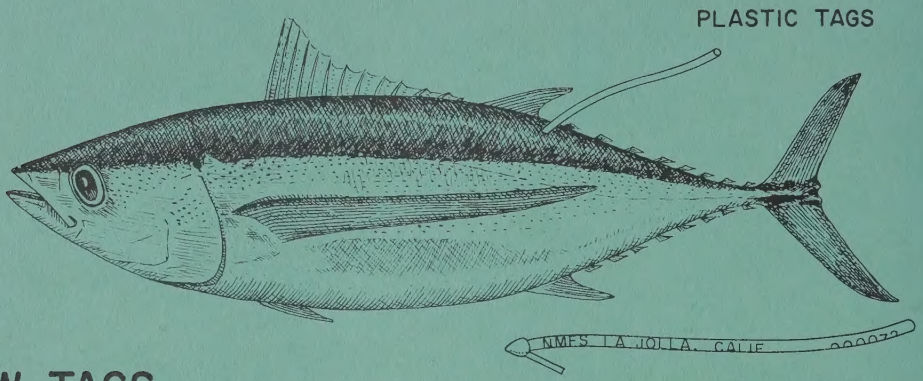
Southwest Fisheries Center-La Jolla, California



noaa NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION / NATIONAL MARINE FISHERIES SERVICE

$ REWARD $

FOR ALBACORE TUNA TAGS



YELLOW TAGS

THE NATIONAL MARINE FISHERIES SERVICE WILL PAY $ 2.00 FOR EACH YELLOW TAG RECOVERED. (NO NEED TO RETURN FISH)

RECORD:

- ▶ WHERE
- ▶ WHEN
- ▶ HOW

} *FISH WAS CAUGHT*

- ▶ LENGTH OF FISH (TIP OF LOWER JAW TO FORK OF TAIL)

FORWARD TO NMFS ADDRESS ON TAG

RED TAGS

THE NATIONAL MARINE FISHERIES SERVICE WILL PAY $ 50.00 FOR EACH RED TAG & FISH RETURNED. (FISH WITH TAG INTACT MUST BE RETURNED

RECORD:

- ▶ WHERE
- ▶ WHEN
- ▶ HOW

} *FISH WAS CAUGHT*

- ▶ LENGTH OF FISH (TIP OF LOWER JAW TO FORK OF TAIL)

NOTIFY NMFS P.O. BOX 271, LA JOLLA, CA. TEL. (714) 453-2820

THE AMERICAN FISHERMEN'S RESEARCH FOUNDATION WILL AWARD CASH PRIZES FOR YELLOW & RED TAG NUMBERS DRAWN IN AN ANNUAL LOTTERY.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
SOUTHWEST FISHERIES CENTER
8604 LA JOLLA SHORES DRIVE - P. O. BOX 271
LA JOLLA, CALIFORNIA 92037

FISHING INFORMATION

MAY 1978, No. 5

EDITOR: JAMES A. RENNER

I. Barrett, Director, SOUTHWEST FISHERIES CENTER
J. Carr, Deputy Director

PREFACE

This publication, Fishing Information, appears monthly and contains 1) fishery advisory information, 2) a narrative description of pertinent surface temperature conditions, 3) charts of winds and pressures for the eastern North Pacific, 4) charts of sea surface temperature for the North Pacific and eastern tropical Pacific, and 5) charts of subsurface temperature structure in the eastern North Pacific.

A supplement to Fishing Information appears at 15-day intervals throughout the year. It contains a chart of sea surface temperature (contoured at 2°F (1°C) intervals) from Baja California to Vancouver Island out to about 135°W. Special bulletins are published in conjunction with the 15-day sea surface temperature charts which include short-term projections of albacore distribution and locations of productive fishing areas, information on oceanographic and atmospheric conditions, and other information as is appropriate during the albacore fishing season.

To cancel delivery of this publication in the event you no longer need to receive it, or to change the delivery address if you are moving but still need to receive it, please notify us by writing: James A. Renner, Editor, Fishing Information, National Marine Fisheries Service, Southwest Fisheries Center, P.O. Box 271, La Jolla, California 92038.

Submitted for publication - June 27, 1978

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ENVIRONMENTAL CHARTS ANALYZED BY:

F. Miller (Figures 8 and 9)
J. Renner (Figures 1, 2, 3, 4, 5, 6, 7 and 15 day Supplement)

TECHNICAL EDITOR:
R. Allen
CARTOGRAPHY:
R. Allen, H. Orr

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J. Redhead at Langara Island Light; C.T. Hilliar at Cape St. James Light;
L. Collins at Kains Island Light; M.V. Stewart at
Amphitrite Point Light

Scripps Institution of Oceanography, La Jolla, California

Expendable bathythermograph and salinity observations are made by the mates and engineers of the *Californian* of the Matson Navigation Co. The data are processed under supervision of D.R. McLain at the NMFS Pacific Environmental Group, Monterey, California, using computer facilities of the Fleet Numerical Weather Central, Monterey. The project is partially supported by the National Science Foundation and the Office of Naval Research.

Albacore Tuna Forecast for 1978

R. Michael Laurs and Staff
Albacore Fisheries Program
National Oceanic and Atmospheric Administration (NOAA)
National Marine Fisheries Service (NMFS)

A number of conditions exist that could unfavorably affect the availability of albacore off the Pacific west coast and lower fishing success in 1978. We anticipate that most of the U.S. albacore catch during the 1978 fishing season will be taken off central and southern California and southward to Guadalupe Island. We estimate that approximately 75% of the catch will be taken in waters south of San Francisco and 25% in waters to the north.

NORTHERN BAJA CALIFORNIA AND CALIFORNIA SOUTH OF SAN FRANCISCO

Albacore are expected to be available earlier than normal this season in waters off southern California and southward to about Guadalupe Island. It appears that at least a portion of the "southern" group of albacore that form the U.S. fishery in waters south of about San Francisco did not migrate into central Pacific waters, but spent the winter months in waters relatively close to central-southern Baja California. These fish could be available in waters off San Diego-northern Baja California by mid-June. The early availability of fish could contribute to a high seasonal catch from this area; however, there are two oceanographic conditions that, if they persist, could limit the overall fishing success. First, coastal upwelling has been unusually weak along much of the Pacific coast this year. The lack of upwelling can result (a) in less nutrient enrichment of near-surface ocean waters and consequently reduced food animals for albacore, and (b) in weak temperature fronts or "edges" where albacore often aggregate and which can be very important in albacore fishing. If upwelling remains weak, albacore could be relatively scattered and fishing spotty. A second oceanographic condition that could limit fishing success in waters off southern California and Baja California is unusually warm ocean temperatures. Sea surface temperatures in coastal waters off Baja California and southern California have been about 2 to 4°F (1.1 to 2.2°C) warmer than average during winter and spring months. If seasonal warming is not retarded, sea surface temperatures could exceed the 68°F (20°C) upper limit of the optimal temperature preference of albacore by about September. This could cause the fish to move into deeper, cooler waters and be less vulnerable to fishing gear or to move out of the area.

Temperature fronts or "edges" important in albacore fishing are also apparently poorly developed this year in many of the areas off central and northern California, as a result of weak coastal upwelling. If these conditions persist, fishing success could be hindered along much of the west coast of the U.S. Fortunately, however, strong coastal upwelling can be established in response to a few days of brisk northerly winds, and if the winds persist, well-developed temperature boundaries should be formed.

CALIFORNIA NORTH OF SAN FRANCISCO AND THE PACIFIC NORTHWEST

The catch of albacore from waters off the Pacific Northwest is expected to be limited this year. The major reason for this is an anticipated late arrival of the "northern" group of albacore that enter the U.S. fishery north of about San Francisco. Results from albacore research studies in recent years indicate that the group of fish which enter the U.S. fishery off the Pacific Northwest is separate from the group that enters the fishery south of about San Francisco and that the two groups of fish follow different migratory patterns. The "northern" group makes trans-Pacific migrations between the eastern North Pacific and the western North Pacific where they are also fished on by the Japanese albacore fisheries. The "southern" group does not migrate to and from the western Pacific, but probably migrates to the central Pacific, perhaps to the longitudes of the Hawaiian Islands. The Japanese live-bait fishery for albacore was late in starting and slow in developing this year, apparently in response to variations in oceanographic conditions in the western Pacific. This suggests that at least part of the "northern" group of albacore were late in leaving the western Pacific this year for their migration to waters off the

Pacific Northwest. It is not possible to predict how much of the "northern" group will arrive in the eastern Pacific to be available to the U.S. fishery; however, there is a good possibility that a large portion of the fish will not have time to make the migration before ocean waters in the Pacific Northwest cool below the optimal temperature preference for albacore.

Three U.S. jigboats, which sailed from San Diego (one vessel) and Honolulu (two vessels) in early May to conduct albacore exploratory fishing/research studies across the North Pacific and into the western Pacific, made their first substantial catches of albacore (approximately 200 or more fish per day) during the last couple days of May from a body of fish near 35°N, 175°W. If this body of fish, which presumably is migrating to the eastern Pacific, continues to migrate and enters waters off the Pacific Northwest, it should arrive there near mid-August.

HISTORICAL TRENDS IN ALBACORE CATCHES

Seasonal landings of albacore tuna for the North American West Coast (U.S. and Canada) for the period 1938-77 are shown in Plate 1. West Coast landings for the 1977 season, based on preliminary information, were approximately 25.0 million pounds. This is 45% below the average over the past 25 years and down about 40% from the 1975 landings. The 1977 U.S. albacore fishery was plagued by lack of fish in the Pacific Northwest; inconsistent, scattered catches along the rest of the coast; fish that would not "bite," notably off California and Baja California; and high winds and rough seas on many days, especially off northern and central California. The scarcity of fish in the Pacific Northwest appears to have been due to a late migration of albacore from the western Pacific. The inconsistent and scattered catches of albacore which occurred along much of the west coast was related, for the most part, to the failure of albacore forage organisms to concentrate because of poorly developed temperature fronts as the result of weak coastal upwelling. Wind conditions were above-normal in coastal waters along much of California during 1977 summer months and often lowered the effectiveness of fishing effort.

The percentage of the total West Coast catch taken north of San Francisco for the period 1938-77 is shown in Plate 2. The percentage north-south distribution of catch reflects the large shifts in the location of the centers of the albacore fishery which have taken place over the past 4 decades. During 1977, about 30% of the catch was taken north of San Francisco and 70% south.

Albacore landings by states for recent years are as follows:

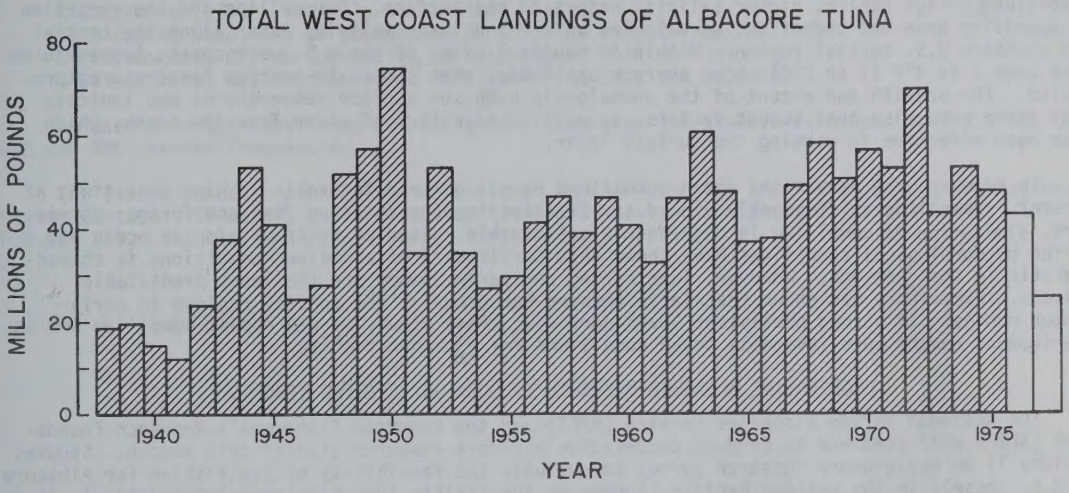
Albacore Landings by State for 1970-77 (millions of pounds)

State	1977*	1976*	1975	1974	1973	1972	1971	1970
California	16.0**	28.0+	15.4	11.8	8.6	21.0	36.1	29.9
Oregon	4.4	5.9	17.1	25.2	16.3	23.1	8.4	21.8
Washington	4.9	7.2	16.3	18.0	14.4	16.2	5.3	4.4
British Columbia	.1**	0.6	0.2	2.6	2.8	7.6	3.7	1.6
Total	25.4	41.7	49.0	57.6	42.1	67.9	53.5	57.7

* Preliminary ** Estimate

TRENDS IN METEOROLOGICAL AND OCEANIC CONDITIONS

The winter of 1977-78 was characterized by significant large-scale anomalies in sea level pressure and other meteorological parameters over the eastern North Pacific. The Aleutian low pressure cell was more deeply developed and broader than usual. The subtropical high pressure cell was either weak and shifted offshore or non-existent in monthly averages. The result of these differences was stronger and more persistent westerlies especially south of 45°N. Also, the westerlies extended to more southerly latitudes than usual and during January through March extended south to 25°N bringing numerous storms and considerable rain to the southwestern U.S. The increased westerlies and their southerly extension effected a displacement of cooler, lower-salinity water, of subarctic origin, southward over a broad region of the central North Pacific. This large region, west of 140°W, displayed sea surface temperatures 2 to 4°F (1 to 2°C) below the seasonal average.



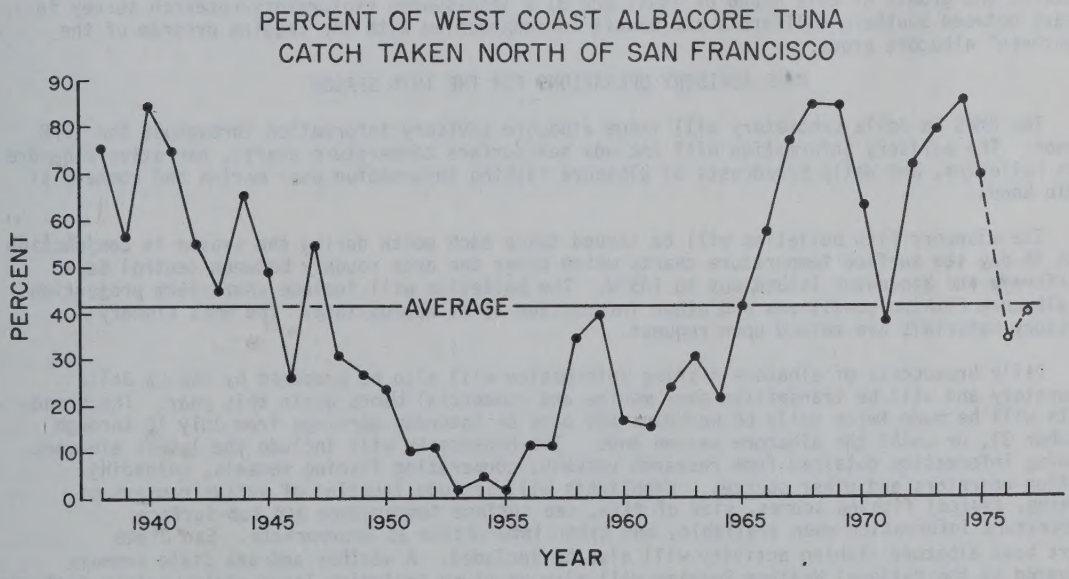


PLATE 1 - Top graph: Total west coast landings of albacore tuna in millions of pounds, 1938-1977.

PLATE 2 - Bottom graph: Percent of west coast albacore tuna catch taken north of San Francisco, 1938-1977.

In the coastal region the effect of the anomalous winds differed. There the southerly component of wind was strengthened (or the northerly component was weakened). As a result of these changes there was stronger-than-average downwelling during 1977-78 winter months along the U.S. west coast and a late arrival (April) of spring upwelling. Upwelling in April was below average from the Canadian to the Mexican borders. Coastal upwelling under typical conditions brings cooler, higher salinity waters to the surface. Downwelling and the reduction in upwelling have had the effect of allowing warmer and lower salinity water along the central and southern U.S. coastal region. Within 40 nautical miles of the U.S. west coast, temperatures have been 2 to 4°F (1 to 2°C) above average until May, when closer-to-average temperatures prevailed. The breadth and extent of the anomalously high sea surface temperatures may indicate that there were also heat budget factors, as well as advection of water from the south, which have been effective in warming the surface layer.

In summary, the prevailing ocean conditions do not portend favorable fishing conditions at present. Upwelling is frequently viewed as effective in concentrating fish and forage; therefore, diminution of upwelling is regarded as unfavorable. Studies of prediction of ocean and marine meteorological conditions have shown that persistence of anomalous conditions is characteristic in some seasons. However, late spring and early summer are the least predictable seasons. Experience has shown that large changes can occur in the coastal regions in early summer months. If strong persistent north-northwest winds occur, we can expect upwelling and an improvement toward more favorable ocean conditions for albacore fishing.

COOPERATIVE ALBACORE RESEARCH/EXPLORATORY FISHING STUDIES

The National Marine Fisheries Service (NMFS) and the American Fishermen's Research Foundation (AFRF) will continue to conduct cooperative albacore research studies this season. Studies include 1) an exploratory research survey to evaluate the feasibility of jig fishing for albacore by U.S. vessels in the western Pacific (funded by the Pacific Tuna Development Foundation); 2) an extensive tagging program of the "southern" group of albacore as part of a study of the migration patterns and growth of this group of fish; and 3) a late-season exploratory/research survey in waters between southern California and Hawaii in conjunction with the tagging program of the "southern" albacore group.

NMFS ADVISORY OPERATIONS FOR THE 1978 SEASON

The NMFS La Jolla Laboratory will issue albacore advisory information throughout the 1978 season. The advisory information will include sea surface temperature charts, narrative albacore fish bulletins, and daily broadcasts of albacore fishing information over marine and commercial radio bands.

The albacore fish bulletins will be issued twice each month during the season in conjunction with 15-day sea surface temperature charts which cover the area roughly between central Baja California and Vancouver Island out to 135°W. The bulletins will include short-term projections of albacore fishing conditions and other information as is appropriate. The NMFS fishery advisory materials are mailed upon request.

Daily broadcasts of albacore fishing information will also be prepared by the La Jolla Laboratory and will be transmitted over marine and commercial bands again this year. The broadcasts will be made twice daily on weekdays and once on Saturday mornings from July 10 through October 31, or until the albacore season ends. The broadcasts will include the latest albacore fishing information obtained from research vessels, cooperating fishing vessels, unloading station operators and other sources. Highlights will include location of active centers of fishing, typical fishing scores, size of fish, sea surface temperature and sub-surface temperature information when available, and other information as appropriate. San Diego sport boat albacore fishing activity will also be included. A weather and sea state summary prepared by the National Weather Service will also be given including large-scale weather features, regional wind, weather, and sea state conditions between 20-250 miles offshore and storm development. NMFS will also transmit weekly charts of sea surface temperature via radio facsimile over radio station WWD on Fridays, at 10:00 PDT on 8644.1 kHz beginning July 1.

Nearly coast-wide reception of the albacore fishery advisory broadcasts will be available again this year. The schedule and frequencies for the broadcasts are as follows:

WWD (La Jolla, CA) on SSB carrier frequencies 4431.8, 8644.1, 8753.0 and 13141.1 kHz at 0615 and 1745 PDT weekdays and 0815 PDT on Saturdays.
NMC (Point Reyes Coast Guard) on SSB carrier frequency 8760.8 at 0645 and 1945 PDT.
KRED (Eureka, CA) - schedule to be given later.
KBBR (North Bend, OR) on commercial AM 1340 kHz at 0605 and 1805 PDT.
KNPT (Newport, OR) on commercial AM 1310 kHz at 0615 and 1830 PDT.
KAST (Astoria, OR) on commercial AM 1370 kHz at 0610 and 1805 PDT.

To determine the upper sideband assigned frequencies for tunable receivers, add 1.4 kHz to WWD and NMC carrier frequencies.

For further details concerning the National Marine Fisheries Service albacore information, please contact: Director, National Marine Fisheries Service, Southwest Fisheries Center, P.O.Box 271, La Jolla, California 92038, telephone: (714) 453-2820.

Sea Surface Temperature and Environmental Conditions

Forrest R. Miller

Eastern North Pacific

During May the Aleutian low and subtropical high pressure centers were near their respective long-term positions (compare Figures 1 and 2). However, central pressures in the Aleutian low were 4 millibars below normal, and central pressures in the subtropical high were 2 to 4 millibars above normal. This resulted in stronger than normal west winds over the Pacific along 45°N west of 140°W and above normal northerly winds along the U.S. west coast from 35°N to 45°N.

Sea surface temperatures (SST) remained above normal from about 135°W to the U.S. west coast, especially where the SST contours bulged northward along 132°W north of 40°N, and west of Baja California along 120°W (Figure 3). However, the increase in northerly winds from 3 to 6 knots above normal east of 130°W resulted in a marked decrease from April to May in the area with positive SST departures of 1°C or greater (Figure 5). The only area where SST's were more than 1°C above normal was west of Baja California where positive departures were 1 to 2°C in April 1978. Near the U.S. west coast between 35°N and 40°N, very strong northerly surface winds persisted for several days at a time and caused considerable wind mixing off the coast and upwelling near shore. The strong winds were associated with periodic intensification of the eastern Pacific high pressure system that extended over the west coast north of 40°N. SST's along the central part of the U.S. west coast were colder in May 1978 than in May 1977 (Figure 7). The opposite situation prevailed along the Pacific coast south of 35°N. The large area of negative SST departures greater than 1°C west of 145°W and between 40°N and 45°N in May 1978 were associated with strong surface winds and ocean mixing that developed because of stronger than normal pressure gradients between the Aleutian low and the eastern Pacific high pressure systems (Figure 2). The north Pacific ocean front was well defined west of 145°W where SST contours were closely spaced between 38°N and 42°N (Figure 3).

Western Pacific

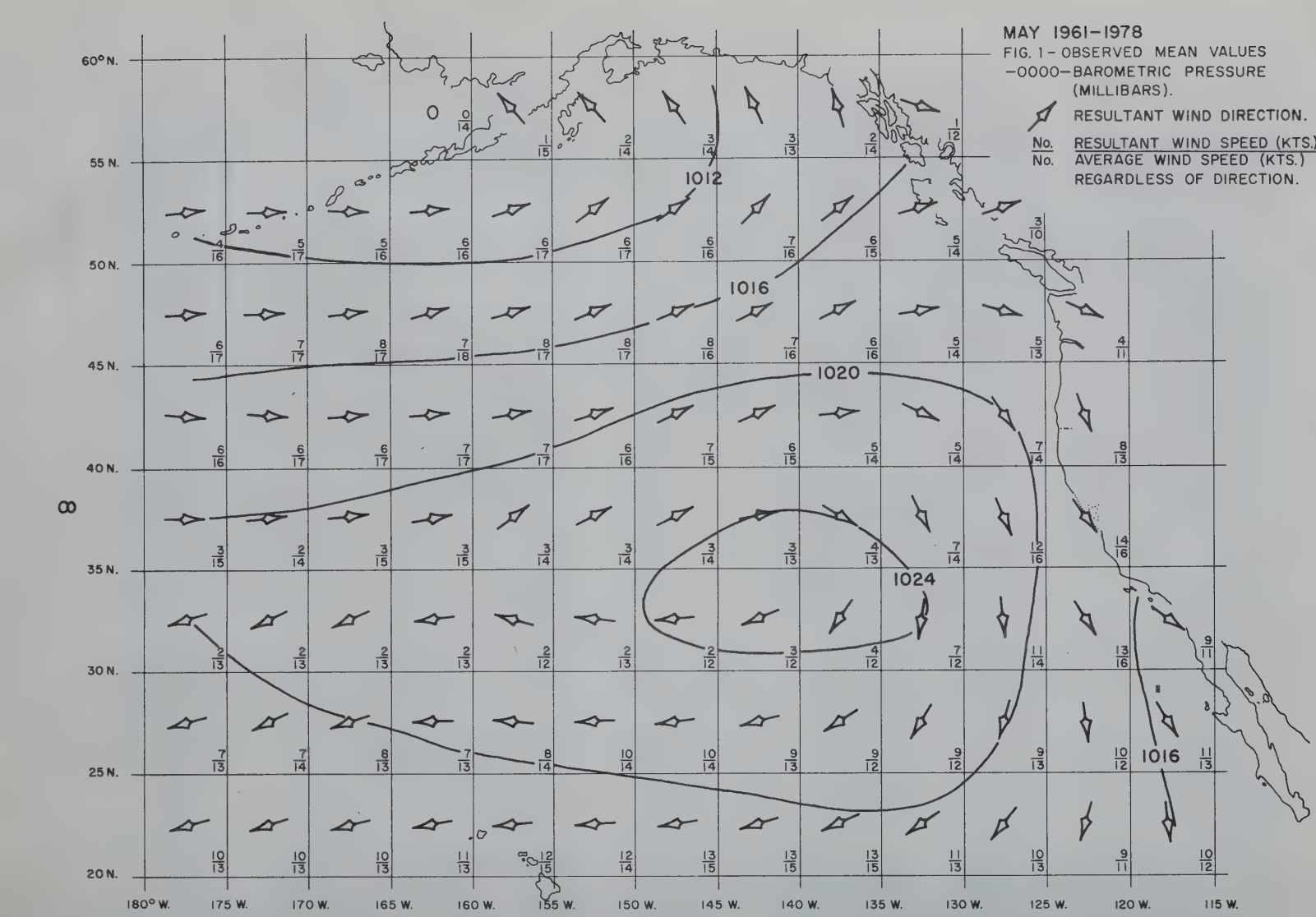
The subtropical high pressure system dominated the lower atmospheric circulation over the central western Pacific in May. Southerly winds east of Japan and north of 30°N persisted where pressures were 2 to 4 millibars above normal. This condition helped to intensify the north Pacific ocean front off the northeast coast of Japan (Figure 4) where the positive SST departures (Figure 6) were probably associated with an increase in northeastward transport of warm water in the Kuroshio Current. The colder than normal SST's along the east coast of Japan north of 35°N also contributed to the intensification of the ocean front in that area. East of 160°E the north Pacific ocean front was stronger than normal between 40°N and 42°N where negative SST departures were 1 to 2°C. The intensification of the western Pacific high pressure system north of 40°N and west of 170°E resulted in above normal northwest surface winds and ocean mixing from 35°N to 45°N between 165°E and 175°W. The subtropical ocean front was stronger than normal east of 150°E between 25°N and 30°N (Figure 4) where SST contours were more closely spaced. The easterly surface winds along the southern periphery of the large and persistent high pressure system were apparently strong enough in April and May to cause extensive mixing of the ocean and generate a large area of negative SST departures more than 1°C south of 35°N. The colder than normal water near 30°N was a major factor in maintaining the subtropical ocean front between 26°N and 28°N and north of the boundary of warm tropical water where SST's were above normal in May.

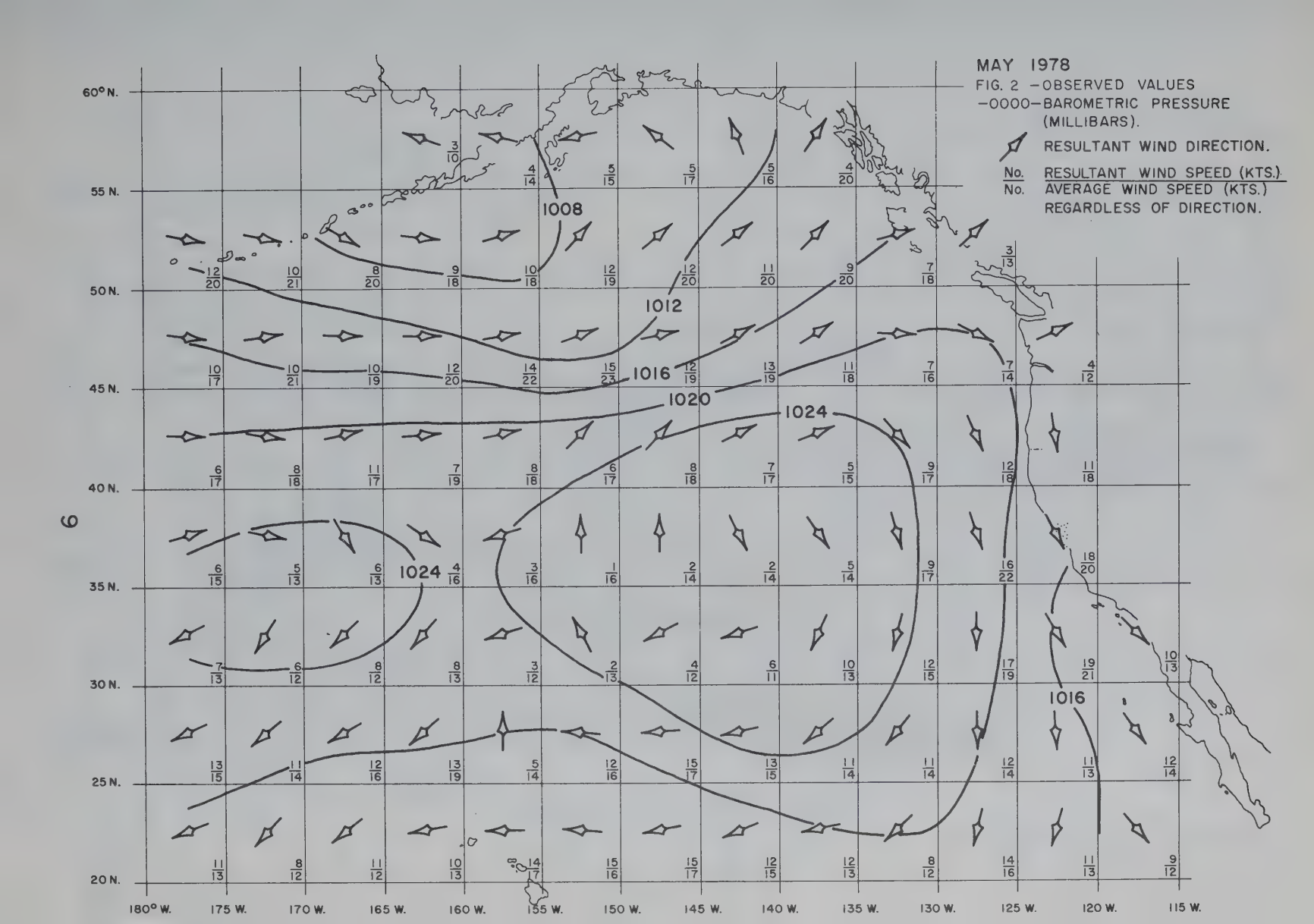
Eastern Tropical Pacific

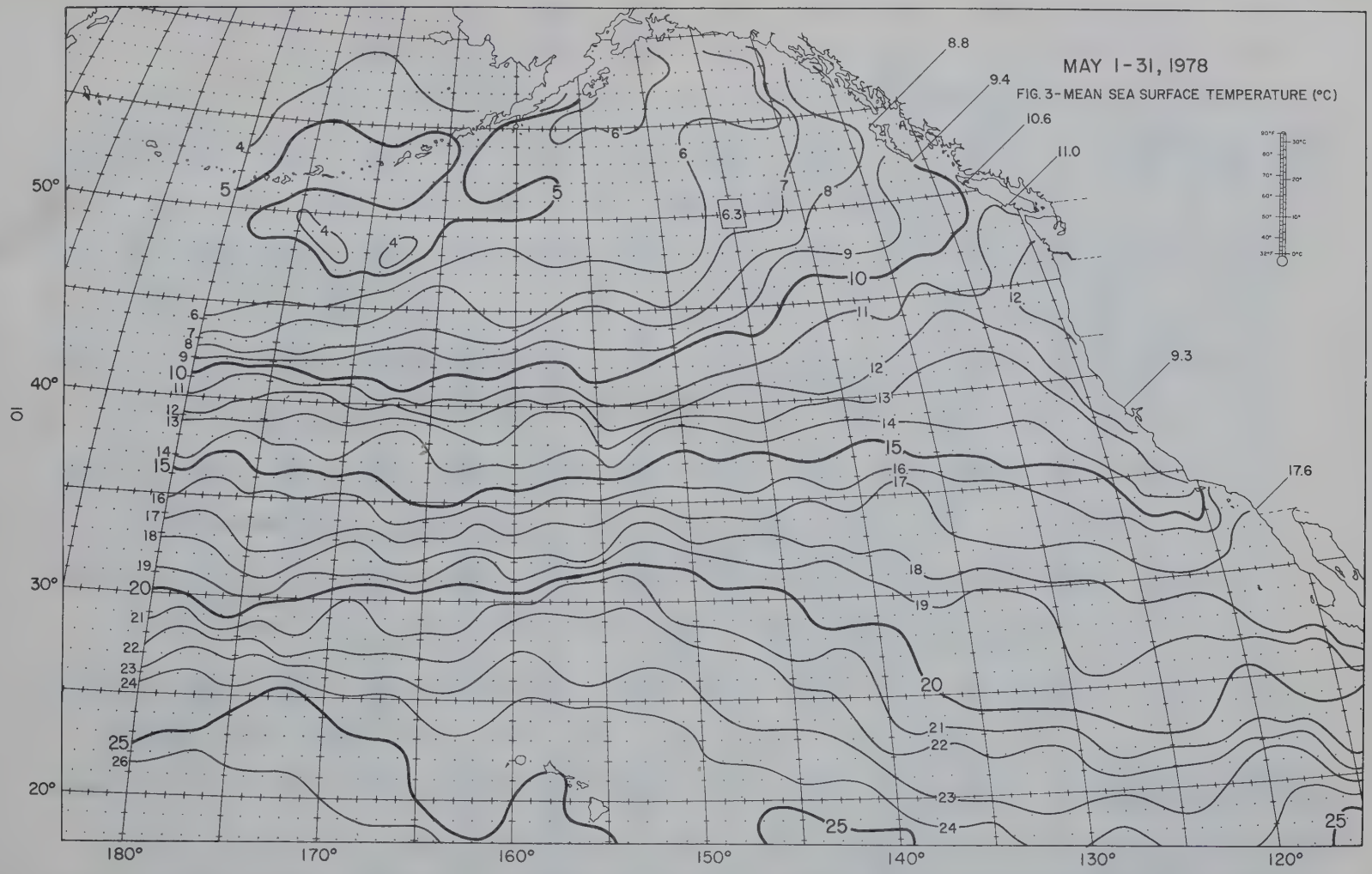
During May, SST's normally increase in the northern hemisphere with the largest monthly increases of 1 to 2°C occurring in the Gulfs of California and Panama and along the coast of Mexico from 15°N to 25°N. In the southern hemisphere, seasonal cooling takes place with SST's decreasing as much as 2 to 3°C in the surface layers of the Peru Current. Similar cooling normally takes place along the equator from the coast of Ecuador to 110°W.

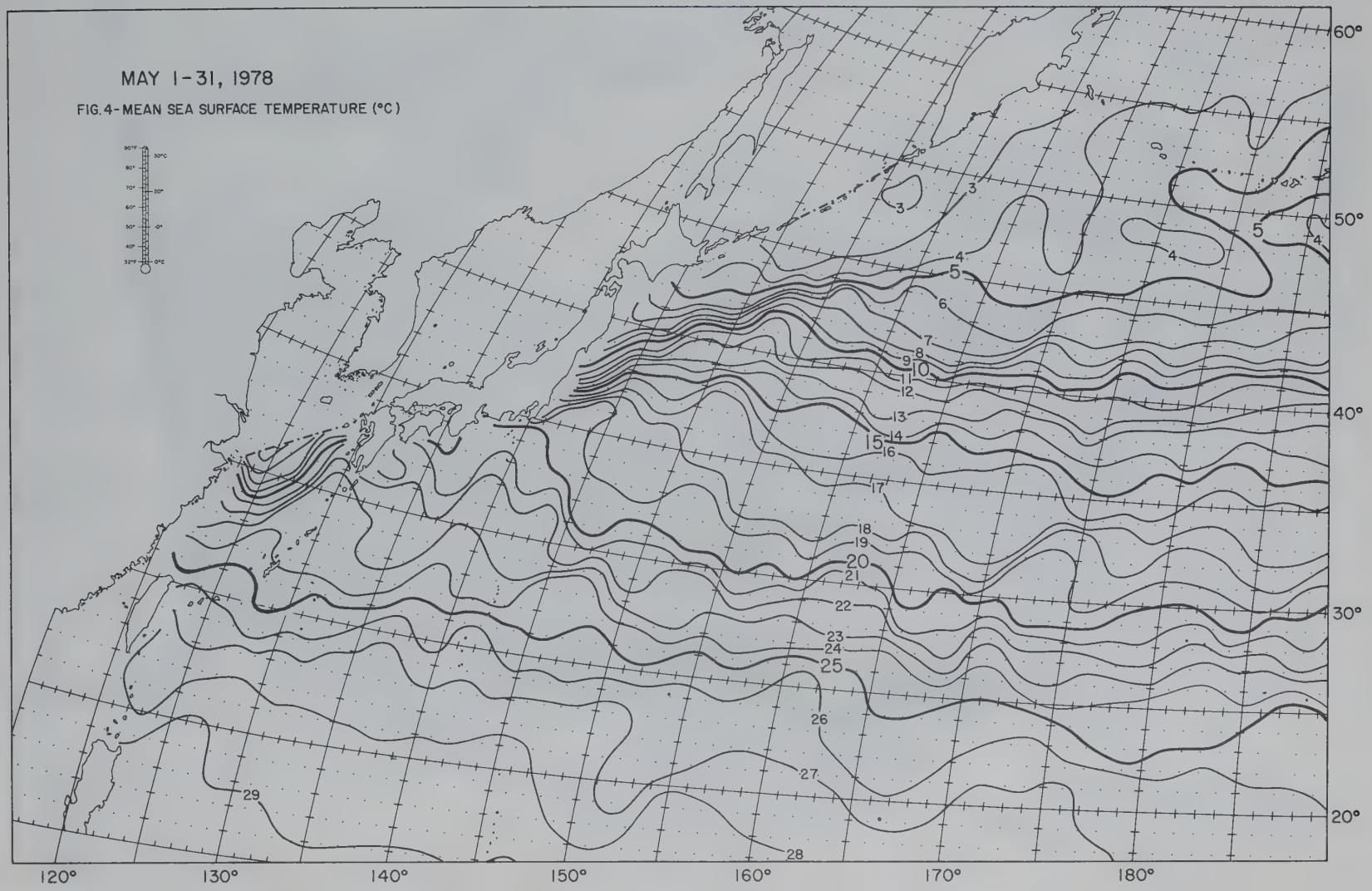
During May 1978, SST's between Baja California and 125°W were more than 1°C above normal in three areas (Figure 9). However, this represented a significant reduction from April 1978 in the size of the subtropical area where SST's had been more than 1°C above normal since January 1978. Less than normal cloud cover west of Baja California, combined with surface winds 2 to 5 knots above normal, resulted in diminished seasonal warming and a reduced area of positive SST departures extending southwest of Baja California. There was considerable tuna fishing activity along the southwest coast of Baja California where a stronger than normal north-south temperature gradient persisted during the month (Figure 8). Along the coast of Mexico from Mazatlán to Acapulco, west of Costa Rica and in the Gulf of Mexico, SST's were more than 1°C below normal where surface winds and cloud cover were greater than normal in association with an active intertropical convergence zone (ITCZ). Frequent squalls developed along the ITCZ between Panama and Costa Rica and moved northwestward through the fishing grounds causing some disruption in fishing activity.

Along the equator from 2°N to 4°S and along the coast of Peru the SST pattern (Figure 8) was characteristic of that associated with a colder than normal or anti-El Niño year. Although the equatorial area covered by negative SST departures greater than 1°C was not larger than in April, the persistence of the negative SST departures along the coast of Peru and out to 180° along the equator suggested that upwelling had become more active, causing SST's to decrease at faster rates than normal. The southern hemisphere subtropical high pressure system was weaker than normal during the first half of May and stronger than normal during the last half of May. This resulted in some periods of below normal surface winds followed by other periods of above normal winds from 75°W to 90°W along the coasts of Peru and Ecuador. West of 90°W from 10°S to 25°S surface winds were 3 to 5 knots above normal during the month and SST's over most of the area west of 90°W and south of 5°N cooled at seasonal rates. Tuna fishing along the north coast of Ecuador was good during most of the month in the coastal area where the equatorial ocean front (Figure 8) had a stronger than normal horizontal temperature gradient from the equator at 85°W to the Gulf of Guayaquil.


MAY 1961–1978
FIG. 1 – OBSERVED MEAN VALUES
–0000– BAROMETRIC PRESSURE (MILLIBARS).
RESULTANT WIND DIRECTION.
No. RESULTANT WIND SPEED (KTS.)
No. AVERAGE WIND SPEED (KTS.) REGARDLESS OF DIRECTION.
1012
1016
1020
1024
1016
60° N.
55 N.
50 N.
45 N.
40 N.
35 N.
30 N.
25 N.
20 N.
180° W.
175 W.
170 W.
165 W.
160 W.
155 W.
150 W.
145 W.
140 W.
135 W.
130 W.
125 W.
120 W.
115 W.


MAY 1978
FIG. 2 —OBSERVED VALUES
—0000— BAROMETRIC PRESSURE (MILLIBARS).
RESULTANT WIND DIRECTION.
No. / No. RESULTANT WIND SPEED (KTS.) / AVERAGE WIND SPEED (KTS.) REGARDLESS OF DIRECTION.
1008
1012
1016
1020
1024
1024
1016
60° N.
55 N.
50 N.
45 N.
40 N.
35 N.
30 N.
25 N.
20 N.
180° W.
175 W.
170 W.
165 W.
160 W.
155 W.
150 W.
145 W.
140 W.
135 W.
130 W.
125 W.
120 W.
115 W.


MAY 1-31, 1978
FIG. 3-MEAN SEA SURFACE TEMPERATURE (°C)
8.8
9.4
10.6
11.0
9.3
17.6
6.3
50°
40°
30°
20°
180°
170°
160°
150°
140°
130°
120°
01


MAY 1-31, 1978
FIG.4-MEAN SEA SURFACE TEMPERATURE (°C)
60°
50°
40°
30°
20°
120°
130°
140°
150°
160°
170°
180°
3
4
5
6
7
8
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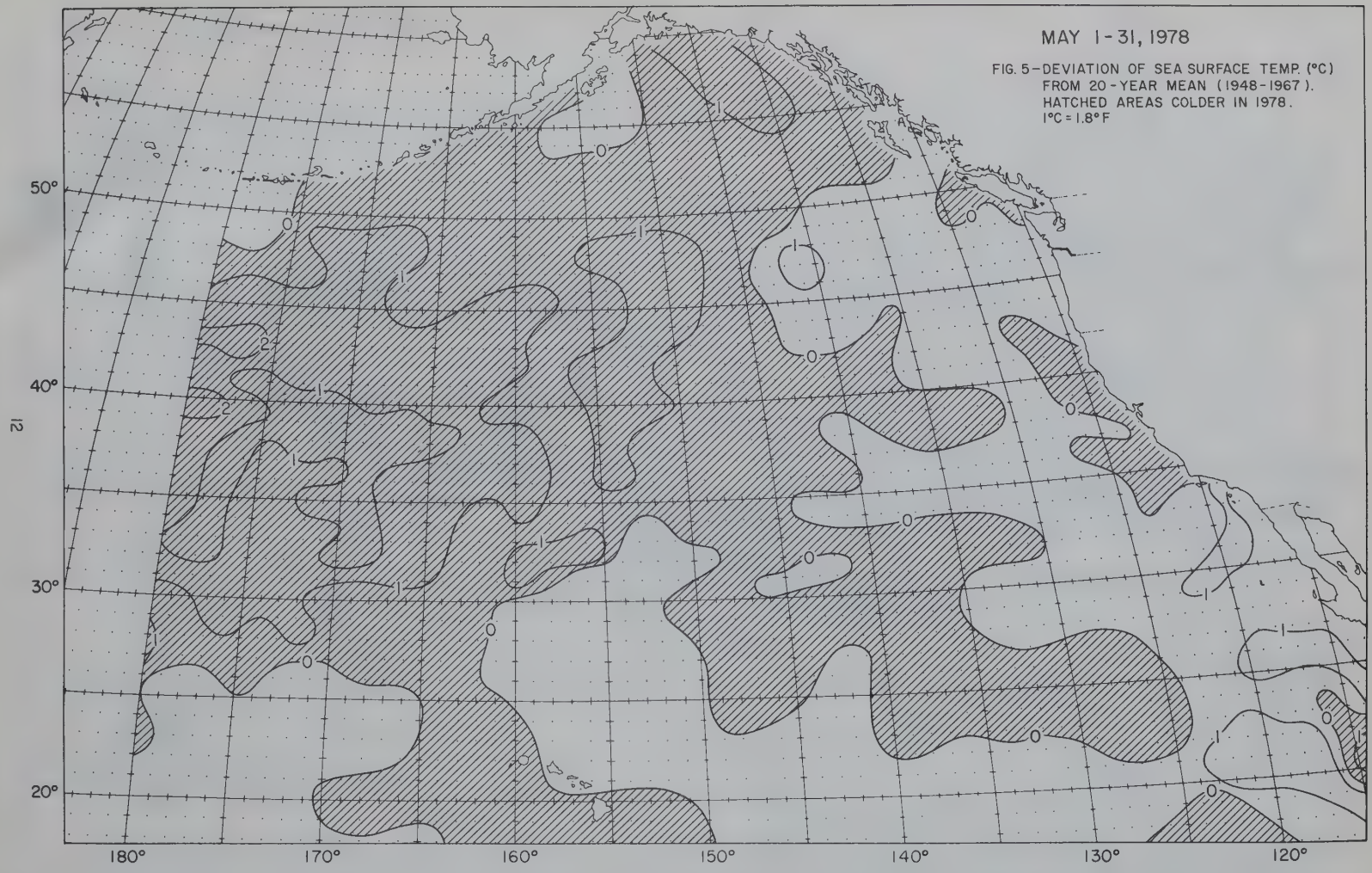
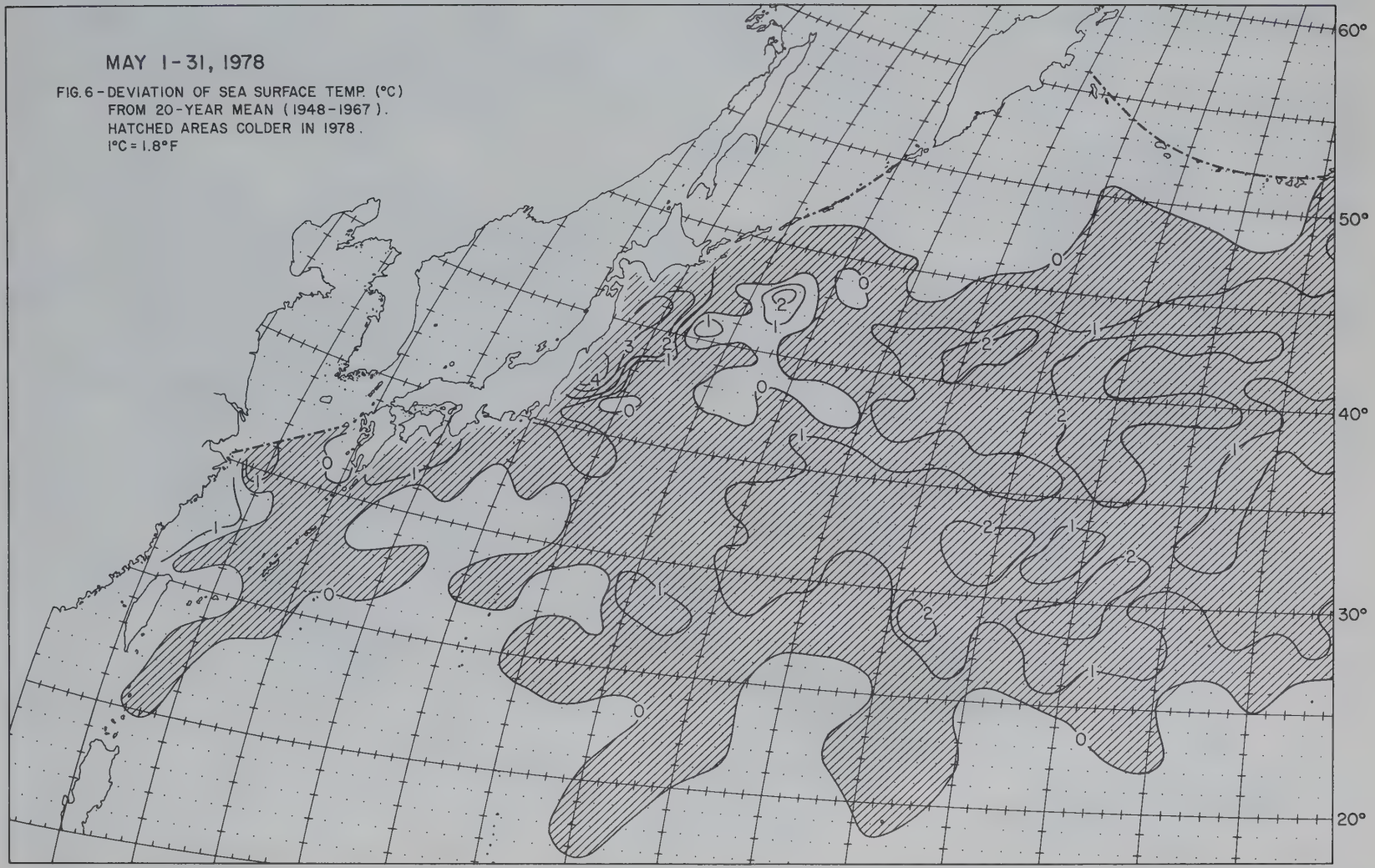
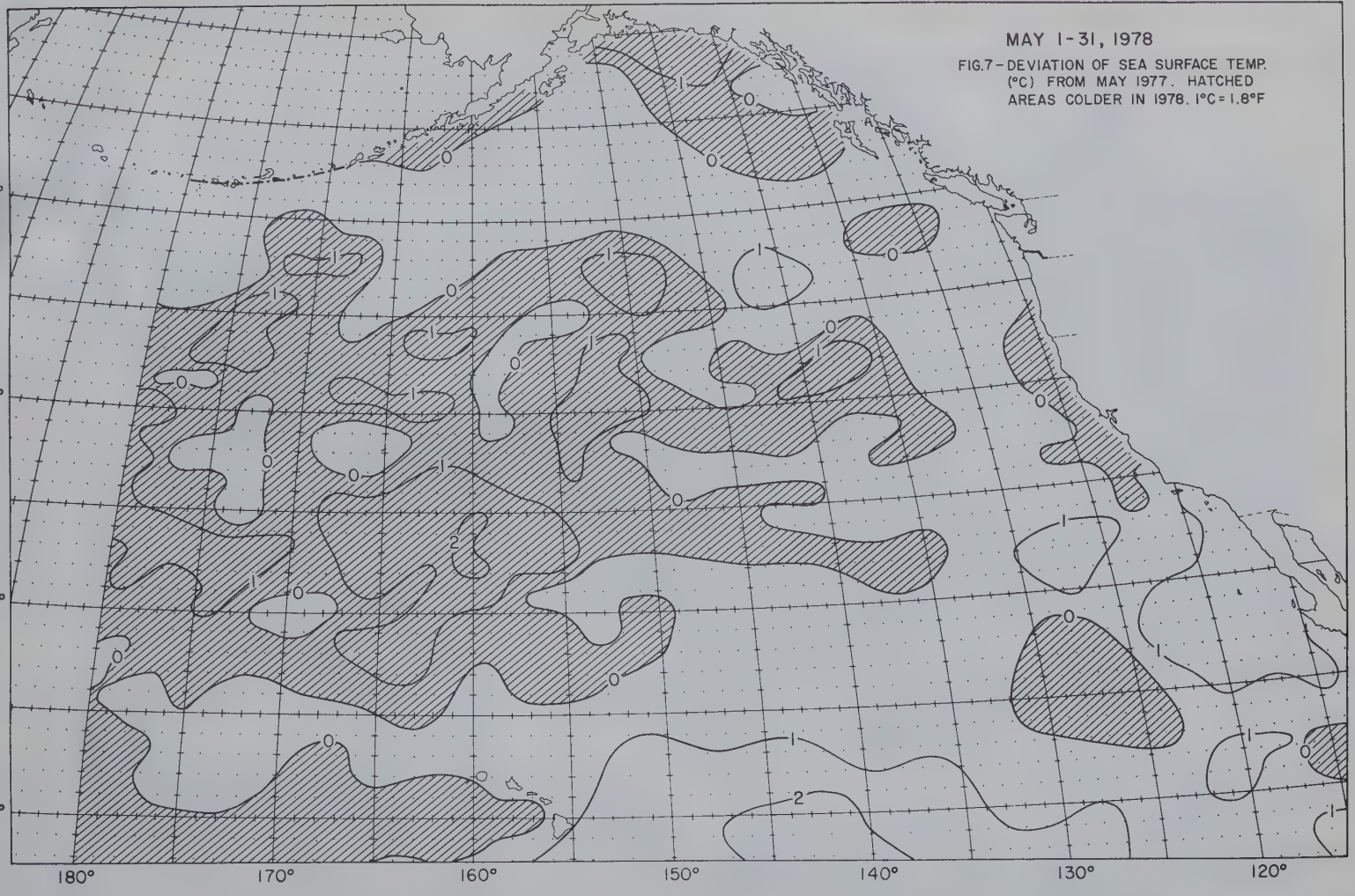
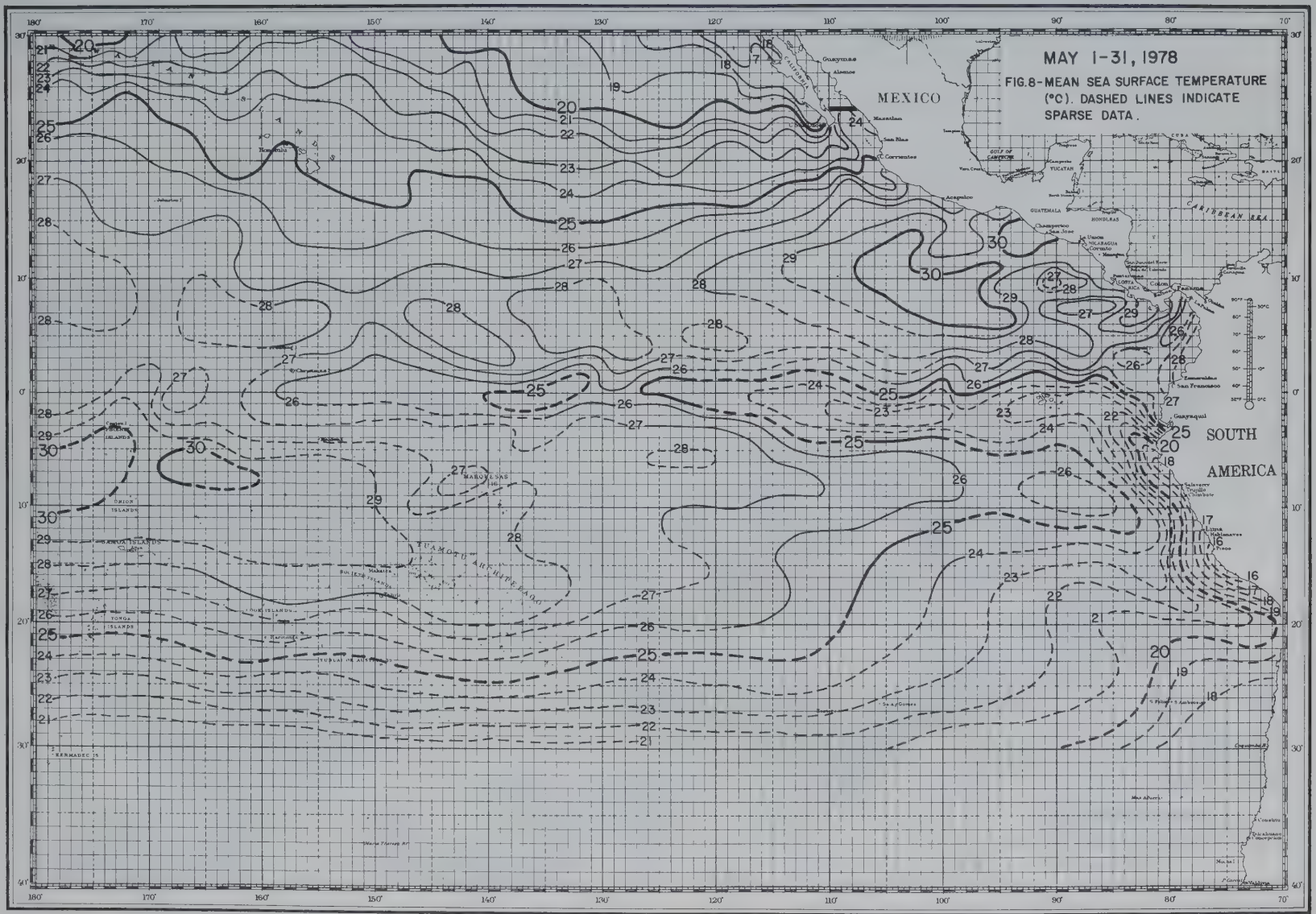

MAY 1-31, 1978
FIG. 5-DEVIATION OF SEA SURFACE TEMP. (°C) FROM 20-YEAR MEAN (1948-1967). HATCHED AREAS COLDER IN 1978.
1°C = 1.8°F
50°
40°
30°
20°
180°
170°
160°
150°
140°
130°
120°
12


MAY 1-31, 1978
FIG. 6 - DEVIATION OF SEA SURFACE TEMP. (°C) FROM 20-YEAR MEAN (1948-1967). HATCHED AREAS COLDER IN 1978.
1°C = 1.8°F
60°
50°
40°
30°
20°
120°
130°
140°
150°
160°
170°
180°


MAY 1-31, 1978
FIG.7-DEVIATION OF SEA SURFACE TEMP. (°C) FROM MAY 1977. HATCHED AREAS COLDER IN 1978. 1°C = 1.8°F
50°
40°
30°
20°
180°
170°
160°
150°
140°
130°
120°


MAY 1-31, 1978
FIG.8-MEAN SEA SURFACE TEMPERATURE (°C). DASHED LINES INDICATE SPARSE DATA.
MEXICO
SOUTH AMERICA
CARIBBEAN SEA
GUATEMALA
HONDURAS
NICARAGUA
COSTA RICA
PANAMA
COLOMBIA
ECUADOR
PERU
CUBA
HAITI
JAMAICA
GULF OF CALIFORNIA
GULF OF CARIBBEAN
YUCATAN
Acapulco
Guaymas
Mazatlan
San Blas
Corrientes
Champerico
San Jose
Corinto
Panama
Colon
Esmeraldas
San Francisco
Guayaquil
Salaverry
Trujillo
Chimbote
Lima
Callao
Pisco
Honolulu
Hawaiian Islands
Marquesas Islands
Tuamotu Archipelago
Society Islands
Tonga Islands
Samoa Islands
Union Islands
Kermadec Is.
Tubuai Islands
Easter Island
Juan Fernandez Is.
Galapagos Is.

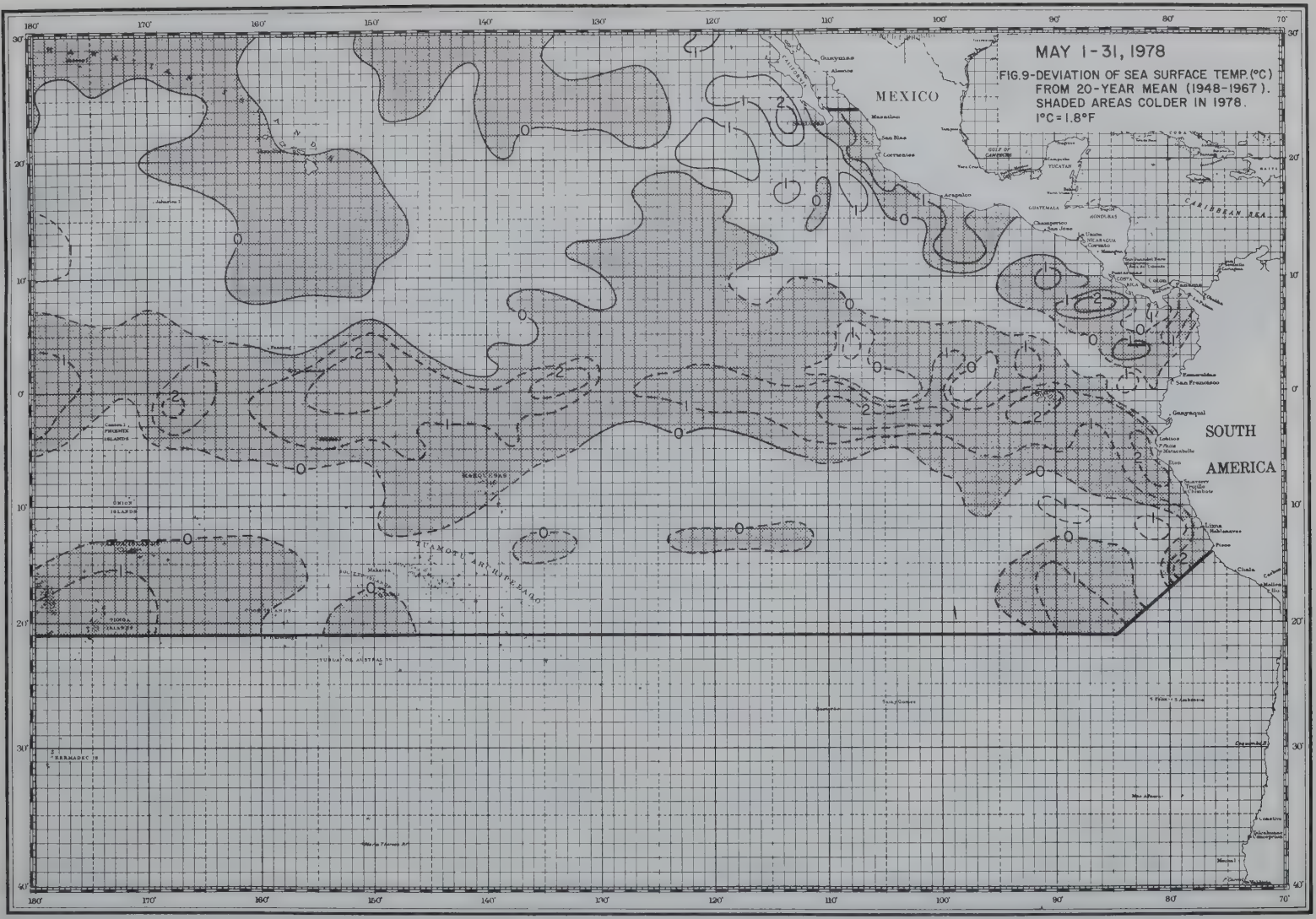
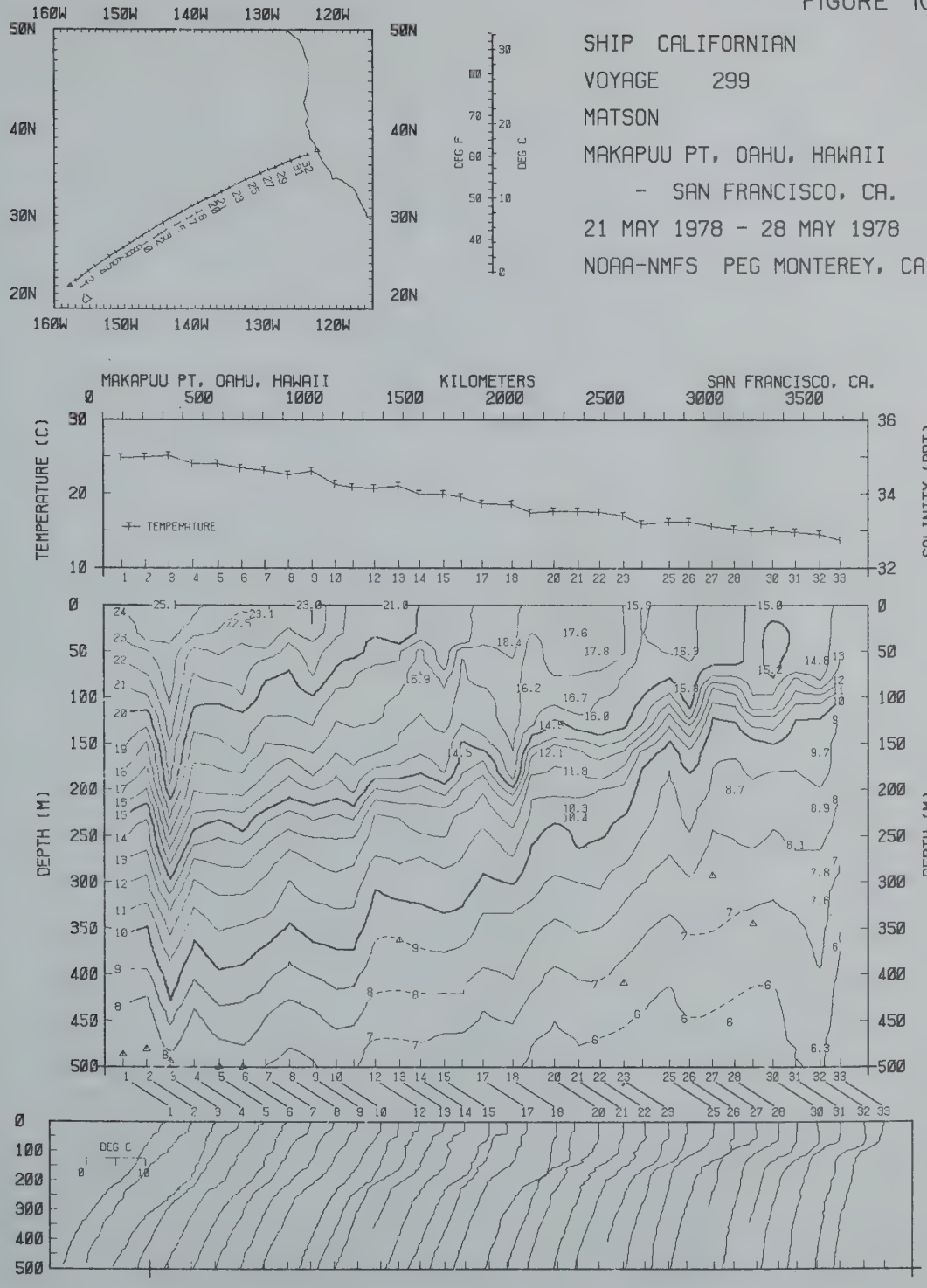
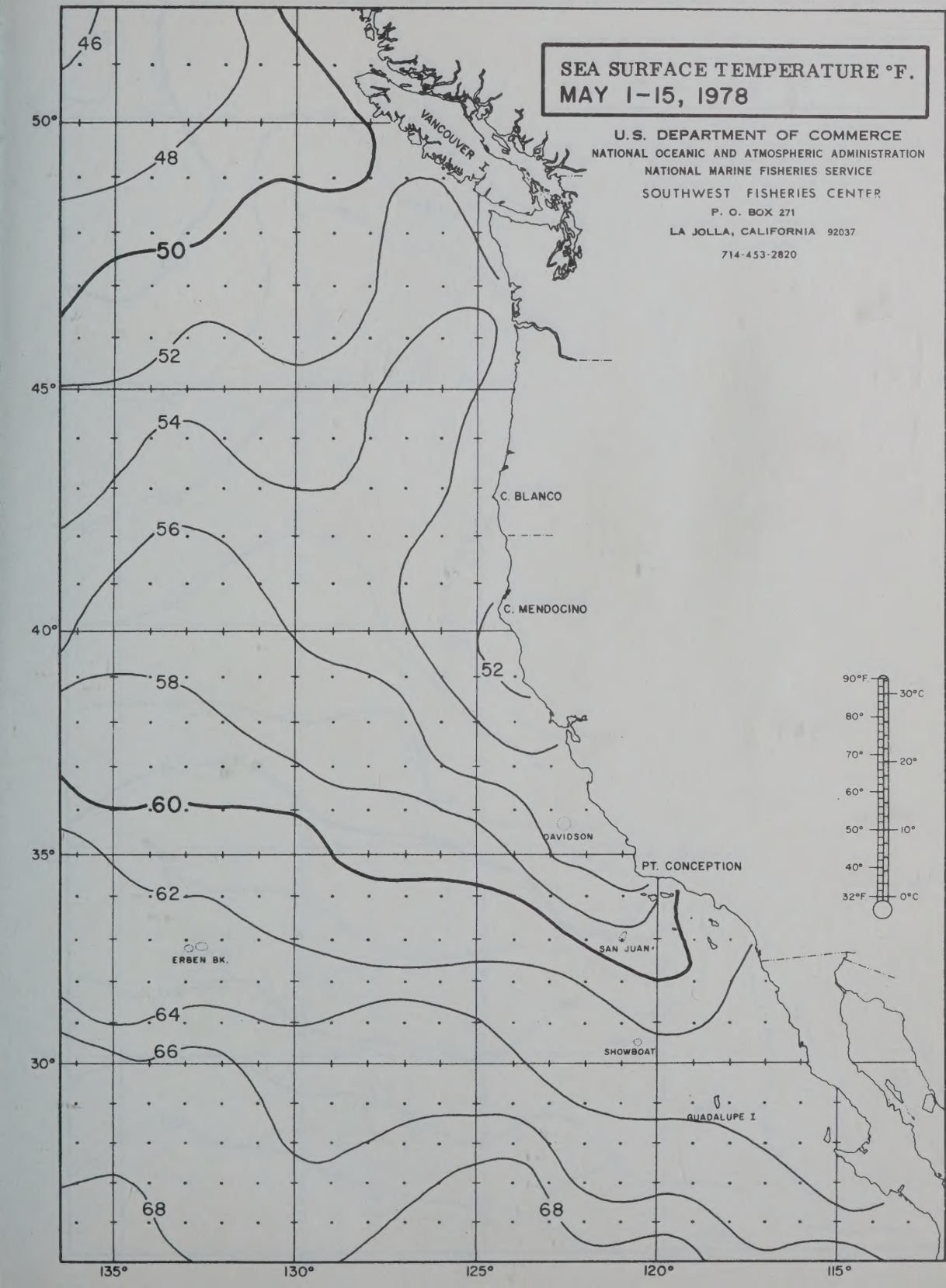

MAY 1-31, 1978
FIG.9-DEVIATION OF SEA SURFACE TEMP.(°C) FROM 20-YEAR MEAN (1948-1967). SHADED AREAS COLDER IN 1978.
1°C = 1.8°F
MEXICO
SOUTH AMERICA
CARIBBEAN SEA
GUATEMALA
HONDURAS
NICARAGUA
COSTA RICA
PANAMA
COLOMBIA
ECUADOR
PERU
GALAPAGOS ISLANDS
EASTER ISLAND
TUBUAI OR AUSTRAL IS.
TUAMOTU ARCHIPELAGO
BERMUDEZ IS.
Guaymas
Mazatlan
San Blas
Corrientes
Acapulco
Champerico
San Jose
Corinto
Panama
Tumaco
Esmeraldas
San Francisco
Guayaquil
Salinas
Talara
Lima
Callao
Pisco
Chala
Mollendo
Arica
Iquique
Antofagasta
Valparaiso
Concepcion
Talcahuano
Puerto Montt
Chiloe
Tumbes
Manta
Puerto Pizarro
Puerto Armuelles
Puerto Limon
Puerto Cortes
Belize
Progreso
Veracruz
Tampico
Yucatan
Campeche
Merida
Havana
Haiti
Jamaica
Cuba
Cocos I.
Malpelo I.
Juan Fernandez Is.
Marquesas Is.
Tahiti
Pitcairn I.
Rapa I.
Raivavae I.
Rurutu I.
Rimatara I.
Rarotonga
Aitutaki
Manuae
Penrhyn
Nassau I.
Suwarrow I.
Palmerston I.
Niue I.
Samoa
Tonga
Fiji
Kermadec Is.
Norfolk I.
New Caledonia
Loyalty Is.
Vanuatu
Solomon Is.
Gilbert Is.
Ellice Is.
Marshall Is.
Wake I.
Johnston I.
Line Is.
Phoenix Is.
Tokelau Is.
Union Islands
Christmas I.
Fanning I.
Malden I.
Starbuck I.
Caroline I.
Flint I.
Vostok I.
Jarvis I.
Howland I.
Baker I.
Enderbury I.
Canton I.
Phoenix Islands
Tokoa Islands
Malaita
Bougainville
Guadalcanal
Espiritu Santo
Efate
Aneityum
Mare
Lifou
Maria Theresa Ar.
Mar de Flores
Mar de Pinares
Isla Coiba
Isla Gorgona
Isla Malpelo
Isla Cocos
Isla Plata
Isla Puna
Isla Lobos
Isla Macabi
Isla Chiloe
Isla Mocha
Isla Santa Maria
Isla Juan Fernandez
Isla Sala y Gomez
Isla Ambrosio
Isla Salas y Gomez
Isla Desventuradas
Isla Pascua
Isla Crucero
Isla Sarmiento
Isla Wellington
Isla Duque de York
Isla Hanover
Isla Londonderry
Isla Evangelistas
Isla Chatham
Isla Pinguino
Isla Diego Ramirez
Isla Hermite
Isla Navarino
Isla Nueva
Isla Picton
Isla Lennox
Isla Gable
Isla Barnevelt
Isla Freycinet
Isla Deceit
Isla Wollaston
Isla Hoste
Isla Stewart
Isla Clarence
Isla Desolacion
Isla Santa Ines
Isla Dawson
Isla Riesco
Isla Magdalena
Isla Tierra del Fuego
Isla Grande
Isla Clarence
Isla Desolacion
Isla Santa Ines
Isla Dawson
Isla Riesco
Isla Magdalena
Isla Tierra del Fuego
Isla Grande

FIGURE 10


160W 150W 140W 130W 120W
50N
40N
30N
20N
DEG F
DEG C
SHIP CALIFORNIAN
VOYAGE 299
MATSON
MAKAPUU PT, OAHU, HAWAII
- SAN FRANCISCO, CA.
21 MAY 1978 - 28 MAY 1978
NOAA-NMFS PEG MONTEREY, CA.
MAKAPUU PT, OAHU, HAWAII
KILOMETERS
SAN FRANCISCO, CA.
TEMPERATURE (C)
SALINITY (PPT)
TEMPERATURE
DEPTH (M)
DEG C

FISHING INFORMATION – supplement



FISHING INFORMATION – supplement